CLAIMS

What is claimed is:

1. A method of making a superabrasive composite material having the general formula $Si_xC_yN_z$, comprising the steps of:

a) depositing a metal-containing catalyst on a substrate;

b) heating the metal-containing catalyst to a temperature sufficient to melt the metal-containing catalyst; and

c) depositing Si, C, and N atoms from a vapor source onto the molten metal-containing catalyst to produce a composite $Si_xC_yN_z$ material having an interatomic structure substantially like that of silicon nitride.

2. The method of claim 1, wherein the Si and C atoms have a Si to C atomic ratio of less than about 1:4 in the vapor source.

3. The method of claim 1, wherein the N atoms are present at from about 2 to about 8 times the Si and C atoms combined.

4. The method of claim 1, wherein the superabrasive composite material has a hexagonal unit cell substantially throughout the crystal structure.

5. The method of claim 1, wherein the superabrasive composite material is substantially free of silicon-carbide bonds.

6. The method of claim 1, wherein the superabrasive composite has a molecular formula of $(Si_VC_W)_3N_4$, such that V+W is about 1.

7. The method of claim 1, wherein X is less than or equal to Y and Z is greater than X or Y.

8. The method of claim 7, wherein X is less than Y.

9. The method of claim 1, wherein Z is greater than X + Y.

10. The method of claim 9, wherein X is less than half of Y.

11. The method of claim 1, wherein the compound has a formula of $(Si,C)_3N_4$

12. The method of claim 1, wherein the substrate contains an element selected from the group consisting of Si, C, N, W, Ta, Ti, as well as compounds, alloys, and mixtures thereof.

13. The method of claim 12, wherein the substrate is Si (111).

14. The method of claim 12, wherein the substrate contains C.

15. The method of claim 1, wherein the substrate is a metal.

16. The method of claim 15, wherein the metal is an alloy of nickel, cobalt, and iron.

17. The method of claim 1, wherein the metal-containing catalyst includes a metal salt.

18. The method of claim 17, wherein the metal salt includes a halide.

19. The method of claim 18, wherein the halide is a member selected from the group consisting of fluorine, chlorine, bromine, iodine, astatine, ions thereof, and mixtures thereof.

20. The method of claim 1, wherein the metal-containing catalyst consists of a metal and alloys thereof.

21. The method of claim 20, wherein the metal is a member selected from the group consisting of gold, silver, platinum, copper, nickel, iron, cobalt, chromium, manganese, zinc, alloys thereof, and mixtures thereof.

22. The method of claim 21, wherein the metal catalyst is gold.

23. The method of claim 1, wherein the metal-containing catalyst is fixed to the substrate.

24. The method of claim 1, wherein the vapor source includes a Si compound, a C compound, and an N compound, each of which contains no more than single bonding arrangements.

25. The method of claim 24, wherein at least one of the Si, C, and N compounds is either a hydride or a halide.

26. The method of claim 24, wherein each of the Si, C, and N compounds is either a hydride or a halide.

27. The method of claim 24, wherein the Si compound is SH_4, the C compound is CH_4, and the N compound is NH_3.

28. The method of claim 24, wherein the Si compound is SCl_4, the C compound is CCl_4, and the N compound is NCl_3.

29. The method of claim 1, wherein the composite material is produced at a rate of from about 20 μm/hr to about 2 mm/hr.

30. The method of claim 1, wherein the substrate is a tool body.

31. The method of claim 30, wherein the tool body is a cutting tool body.

32. The method of claim 30, wherein the tool body is a light emitting diode.

33. The method of claim 1, wherein the superabrasive composite material is in the form

of a member selected from the group consisting of hexagonal column, fiber, grit, film, and combinations thereof.

34. The method of claim 33, wherein the composite material is in the form of grits having a size greater than about 40 micrometers.

35. A method of making a superabrasive composite material having the general formula $Si_xC_yN_z$, comprising the steps of:

a) depositing a metal-containing a catalyst selected from the group consisting of gold, silver, platinum, copper, nickel, iron, cobalt, alloys thereof, and mixtures thereof, on a substrate;

b) heating the metal-containing catalyst to a temperature of from about 800 °C to about 1000 °C, thereby melting the metal-containing catalyst;

c) decomposing single bond compounds containing Si, C, and N atoms from a vapor source; and

d) depositing the Si, C, and N atoms from the single bond compounds onto the molten metal-containing catalyst, to produce a composite $Si_xC_yN_z$ material having an interatomic structure substantially like that of silicon nitride, such that X is less than half of Y and Z is greater than X or Y.

36. A method for making a $Si_xC_yN_z$ compound comprising:

a) depositing Si, C and N elements from a vapor source into a molten metal catalyst; and

b) precipitating the $Si_xC_yN_z$ compound out of the molten metal catalyst.

37. The method of claim 36, wherein said vapor source includes Si, C and N single bond compounds.

38. The method of claim 36, wherein the $Si_xC_yN_z$ compound has an interatomic structure substantially like that of silicon nitride.

39. The method of claim 36, wherein X is less than half of Y and Z is greater than X or Y.

40. A superabrasive composite material having the general formula $Si_xC_yN_z$ such that X is less than half of Y and is substantially free of silicon-carbide bonds.

41. The composite material of claim 40, further having an interatomic structure substantially like that of silicon nitride.

42. The composite material of claim 40, wherein the composite material has a molecular formula of $(Si_VC_W)_3N_4$, such that V+W is about 1.

43. The composite material of claim 40, wherein the composite material is in the form of a member selected from the group consisting of hexagonal column, fiber, grit, film, and combinations thereof.

44. The composite material of claim 40, wherein X is from about 0.05Y to about 0.35Y.

45. A superabrasive composite material having the general formula $Si_xC_yN_z$ such that X is from about 0.05Y to about 0.35Y and is substantially free of silicon-carbide bonds.